Space Weather Technical Forecast

Issued on Monday, 21 February 2022 at 00:41 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storms Day 1 (21 Feb), becoming Slight Chance Day 2 (22 Feb). Slight chance throughout of M-class flares. Increasing Chance of Active fluence levels, mainly from Day 3 (23 Feb) onward.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with a single C-flare from over the NE limb, a C5.1 at 20/0407 UTC. This perhaps from returning ex-2938 which was a likely source of a notable far-sided flare and CME on the 15th. There are four Earth-sided sunspot regions, however these are all simple at the present time. One of which is likely ex-2936, which is currently a simple Hsx/Alpha but may turn out to be more complex as it moves into view in coming days. There was a filament eruption in the southeast disc, which has produced a CME. This is expected to miss Earth. No other Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, has indicated that we have been in the high speed stream from a coronal hole, most likely CH56/+ throughout. The wind speed has fluctuated between slightly elevated and elevated, with a peak 555km/s observed at 20/1651 UTC. The density was initially above average, with a peak of 30ppcc at 20/0136 UTC but has since returned to largely average levels since 20/0420 UTC. The total magnetic field strength (IMF) Bt, was initially moderate 8-12 nT, but fell back to weak after 20/0200 UTC. Bz was initially mainly southward directed, reaching -11 nT, but became more northward directed after the phi angle switched from negative to positive around 20/0200 UTC, varying between +8/-6 nT. Geomagnetic activity was Quiet to Active (Kp 0-4), with a single G1/Minor Storm (Kp 5) interval initially during 20/0000-0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels after a very large and energetic flare and CME from the far sided eastern solar hemisphere on 15 February. The high energy electron flux (greater than 2MeV) has been at background levels. The corresponding 24-hour integrated electron fluence is steady and well below the Active (1e8 integrated pfu) threshold. The 21/0000 UTC observation was 2.06e6 pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low or Very Low at first, but with a slight chance of rising to Moderate through the 4 days due to the potential for flaring from one or more region(s) just starting to rotate onto the NE limb. The other three sunspot regions on the Earth-facing disc are currently unlikely to produce significant flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Earth is experiencing a high speed stream most likely from CH56/+, with this expected to persist during day 1 (21 Feb) and into day 2 (22 Feb), before gradually easing. Geomagnetic activity is expected to be Quiet to Active at first, with a chance of further G1/Minor Storm intervals. This is expected to steadily reduce through the next 24-48 hours, with mainly Quiet activity expected into days 3 and 4 (23 and 24 Feb).

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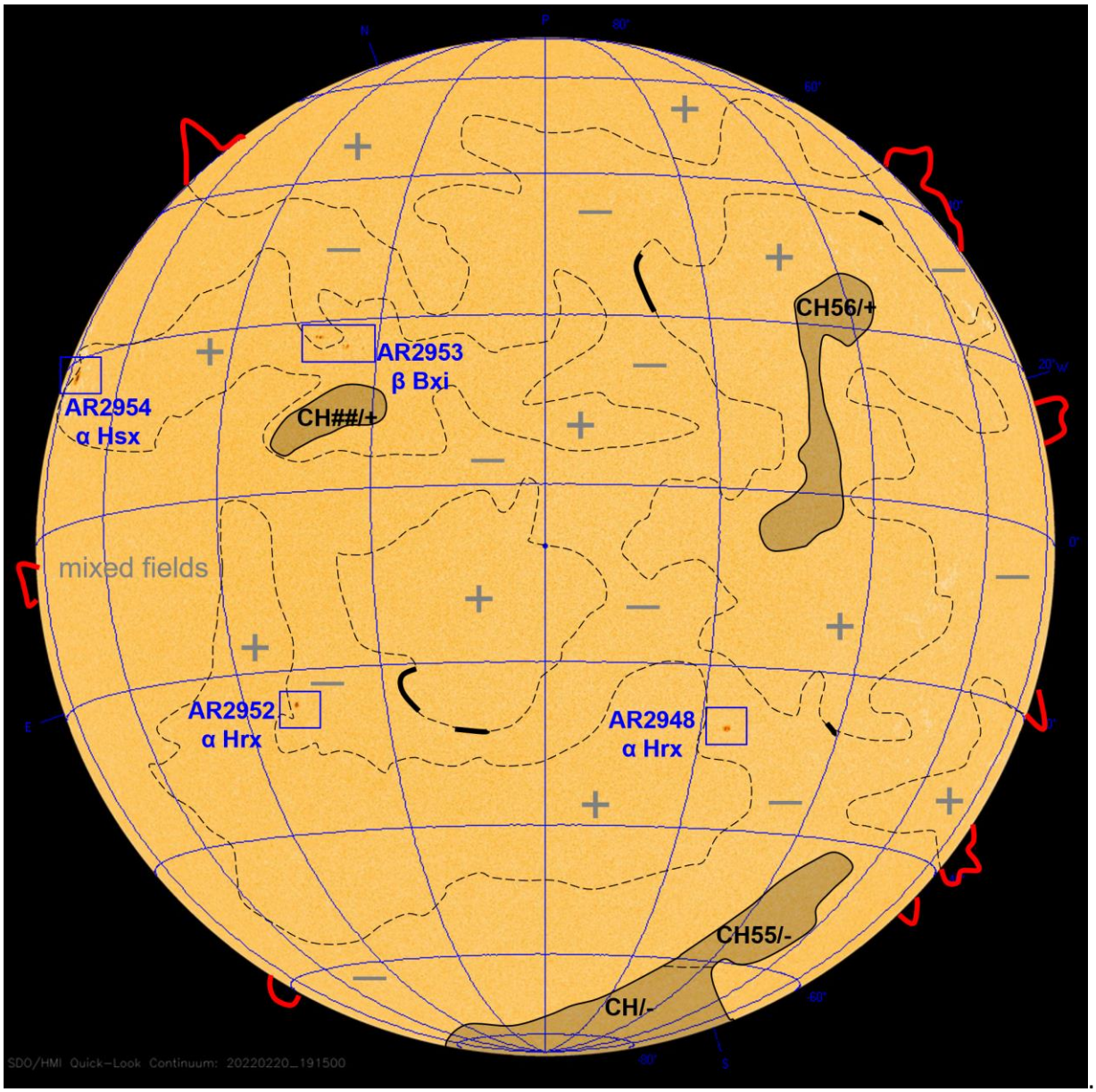
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to soon fall to background levels and then persist at these levels. The high energy (greater than 2 Mev) electron flux is currently at background, but may increase from Day 2 (22 Feb) onwards, becoming Moderate with a chance of peaking at High (greater than 1000 pfu) levels. The associated fluence may also rise as a result, with a chance of reaching the Active threshold (1e8 integrated pfu), most likely on Days 3 and 4 (23 and 24 Feb).

Figure 1. Solar Analysis Valid 20/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

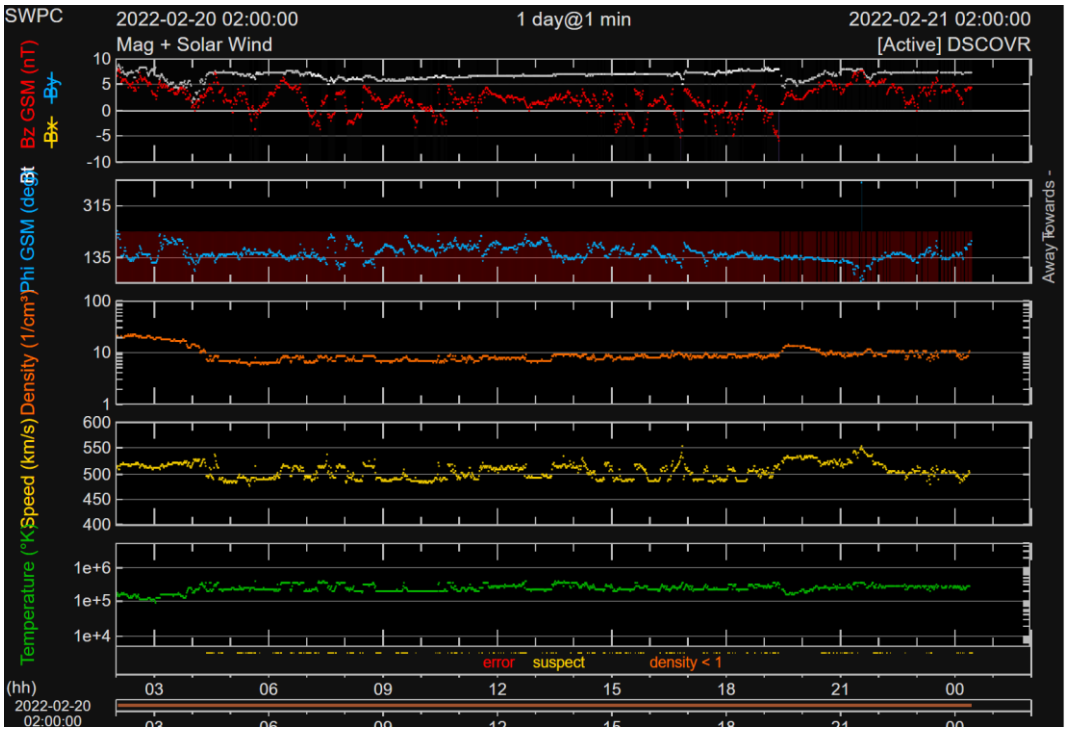
There are no Earth-directed CMEs.

Solar wind speeds are currently elevated, likely due to the high speed stream from a central disc coronal hole, CH56/+. The G1/Minor Storm interval that occurred 20/0000-0300 UTC happened in a negative phase, before the phi angle switched to positive. However, another switch to negative if we are brushing the edge of the two high speed streams can't be ruled out. Given that positive polarity coronal holes are less favoured at this time of year for geomagnetic response, it seems likely that the risk of further G1 intervals is low. Elevated wind speeds are expected to continue through the next 24-48 hours, before a steady decline to background levels.

Consequently, geomagnetic activity is expected to be Quiet to Active at first, with a chance of further G1/Minor Storm intervals. This is expected to steadily reduce through the next 24-48 hours, with mainly Quiet activity expected into days 3 and 4 (23 and 24 Feb).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	10	2	2
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: 24 hour solar wind parameter trace.



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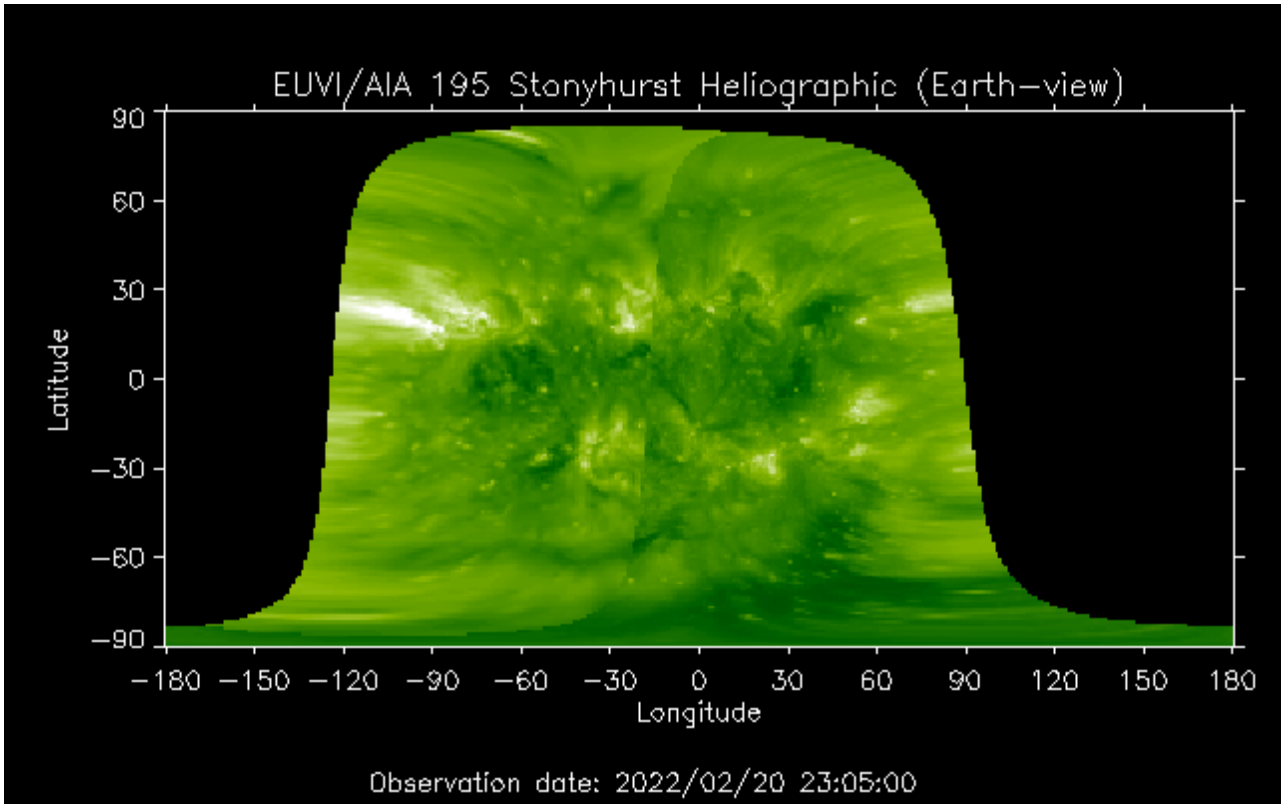
Radio Blackouts - X-Ray Flares:

There are only three small and simple sunspots on the disc, however a new region is currently rotating onto the NE limb. Activity has been Low, with a C-flare from over the NE limb. The three older sunspots, AR2948, AR2952 and AR2953 are all relatively simple and on the whole decaying with a small risk of flaring.

AR2954 has emerged around the northeast limb now, but is currently showing a mature yet simple Hsx/Alpha formation. This may change as this spot come into better view and possible trailer portions emerge. There is also a notably bright area on STEREO-A EVU imagery between 90 and 120 degrees east, which likely corresponds to the source of an energetic flare and CME on the far side on the 15th. Flares from close-to or just over the limb have the potential to be observed at Earth, giving a slight chance of M-flares and activity increasing to Moderate.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: STEREO A EUV imagery showing bright region around the northeast limb.



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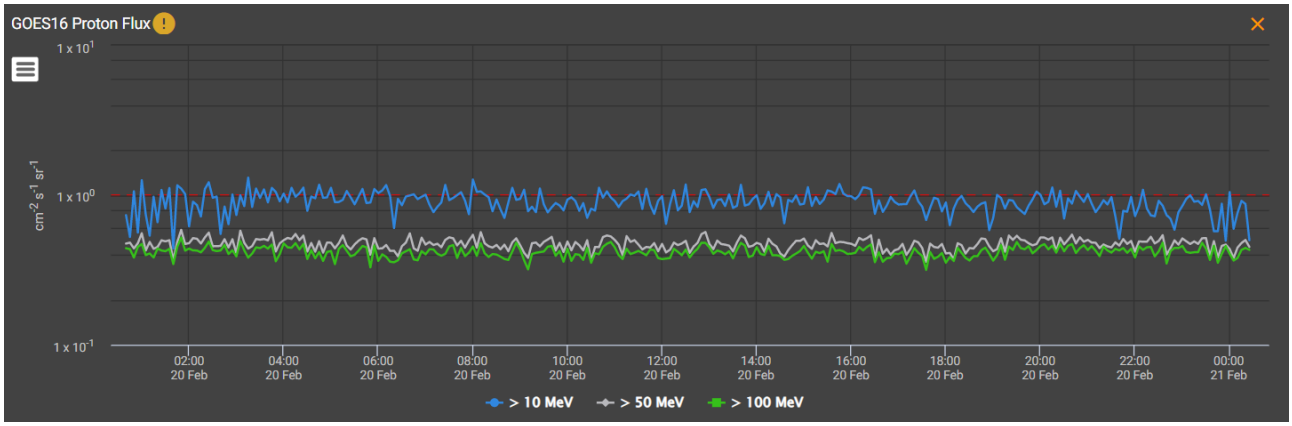
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels since 18/1200UTC. The enhanced activity was due to a very large and energetic flare and CME seen on coronagraph imagery from the rearward eastern solar hemisphere on the 15th. This region is due to rotate onto the Earth-side disc on day 1 (21 Feb), but has not exhibited any further significant activity since this flare. Furthermore, energetic protons are largely guided along the Parker spiral, and consequently radiation storms are notably less likely from the eastern limb for all except the largest flares. Until we can fully assess an ongoing flare risk from this region, the chance of proton storms (S1, which is greater than 10pfu) is maintained at background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES 16 24 hour Proton Flux trace.



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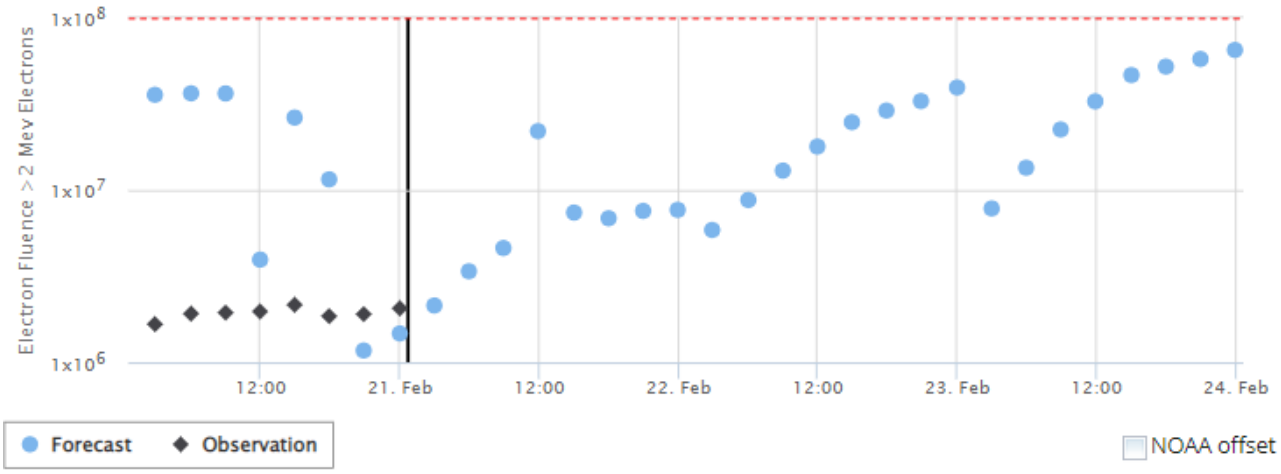
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO is currently at background, having dropped out on the 19th. With solar winds now having risen to near elevated levels due to a recent coronal hole fast wind arrival, renewed electron charging is certainly possible. Electron flux may rise in the coming days, perhaps peaking at High (greater than 1000 pfu) from Day 2 (22 Feb) onward. On Days 3 and 4 (23-24 Feb), more persistently Moderate to potentially High flux is possible.

The associated 24 hour Fluence is currently well below the Active threshold and on a flat trend. In response to the weakening of the solar wind and the recent charging event, there is a gradually increasing chance of Fluence levels becoming Active. Initially during Day 1 and Day 2 (21 and 22 Feb) this will be a Slight Chance, and from Day 3 into Day 4 (23 & 24 Feb) this Chance increases to Likely. REFM is showing an overall rising trend in electron fluence over the coming days and can be used as a rough guide for likely fluence values.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	20	40	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: REFM observed and forecast electron Fluence.



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